Date: January 13, 2015
Client: Headsight, Inc.
Model: Terrahawk
Test: Pre-Compliance testing
UST Project No.: 15-0275

Test Configuration

The Headsight model Terrahawk, which will be referred to as EUT, was configured as it would be in normal operation. The EUT was positioned on a testing platform that allowed it to be at 1, 2, or 3 meters height above the ground and at a variable incline. Absorbing foam was placed underneath the EUT to simulate the ground. The space between the EUT and ground, left open.

For each measurement, the emission was maximized by rotating the turntable and height of the receiving antenna to determine the worst case configuration. Max hold was used to measure any emission and the receiving antenna was configured in both horizontal and vertical polarities.

GPS Bands and Worst Case Configuration

The radiated emissions coming from the EUT in the bands 1164 MHz to 1240 MHz and 1559 MHz to 1610 MHz (GPS Bands) were measured per CFR 15.509 (e) and 15.521 (g). In each of these bands, the emissions from the transmitter were maximized using a larger resolution bandwidth (1 MHz) and the peak detector, then the resolution bandwidth was decreased (1 kHz) and the final measurement was taken using the average detector. Preliminary testing was done to determine that the worst case incline for the EUT was 20˚.

The radiated emissions in these bands were also completed with the EUT at a height of 1, 2 and 3 meters from the ground. The data is presented below.

Table 1. GPS Bands 20˚ at 1 Meter Height

Frequency (MHz)	AF Table	Test Data (dBuV)	Additional Factor	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
1166.47	2Hn3mV	8.72		-10.41	-1.69	19.9	3.0m./VERT	21.6	AVG
1177.80	2Hn3mV	7.92		-10.31	-2.39	19.9	3.0m./VERT	22.3	AVG
1222.10	2Hn3mV	6.76		-9.36	-2.60	19.9	3.0m./VERT	22.5	AVG
1204.60	2Hn3mV	6.26		-9.45	-3.19	19.9	3.0m./VERT	23.1	AVG
1566.70	2Hn3mV	3.42		-8.08	-4.66	19.9	3.0m./VERT	24.6	AVG
1583.16	2Hn3mV	3.49		-7.91	-4.42	19.9	3.0m./VERT	24.3	AVG
1594.15	2Hn3mV	4.99		-7.91	-2.92	19.9	3.0m./VERT	22.8	AVG
1600.05	2Hn3mV	20.26		-7.24	13.02	19.9	3.0m./VERT	6.9	AVG
1600.00	2Hn3mH	26.00		-7.26	18.74	19.9	3.0m./HORZ	1.2	AVG
1571.80	2Hn3mH	11.44		-8.10	3.34	19.9	3.0m./HORZ	16.6	AVG
1604.70	2Hn3mH	11.39		-7.24	4.15	19.9	3.0m./HORZ	15.7	AVG
1609.24	2Hn3mH	9.45		-7.22	2.23	19.9	3.0m./HORZ	17.7	AVG
1165.71	2Hn3mH	10.10		-10.24	-0.14	19.9	3.0m./HORZ	20.0	AVG
1191.36	2Hn3mH	9.87		-10.07	-0.19	19.9	3.0m./HORZ	20.1	AVG
1218.72	2Hn3mH	8.59		-9.37	-0.78	19.9	3.0m./HORZ	20.7	AVG
1199.91	2Hn3mH	9.99		-10.07	-0.08	19.9	3.0m./HORZ	20.0	AVG

Table 2. GPS Bands 20˚ at 2 Meters Height

Frequency (MHz)	AF Table	Test Data (dBuV)	Additional Factor	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
1561.17	2Hn3mH	7.32		-8.11	-0.80	19.9	3.0m./HORZ	20.7	AVG
1577.36	2Hn3mH	10.28		-8.10	2.18	19.9	3.0m./HORZ	17.7	AVG
1604.01	2Hn3mH	9.41		-7.26	2.15	19.9	3.0m./HORZ	17.8	AVG
1600.06	2Hn3mH	21.58		-7.26	14.32	19.9	3.0m./HORZ	5.6	AVG
1173.10	2Hn3mH	9.56		-10.14	-0.58	19.9	3.0m./HORZ	20.5	AVG
1190.96	2Hn3mH	9.71		-10.07	-0.36	19.9	3.0m./HORZ	20.3	AVG
1204.46	2Hn3mH	9.14		-9.45	-0.31	19.9	3.0m./HORZ	20.2	AVG
1229.17	2Hn3mH	8.95		-9.31	-0.36	19.9	3.0m./HORZ	20.3	AVG
1599.93	2Hn3mV	22.09		-7.91	14.18	19.9	3.0m./VERT	5.7	AVG
1566.78	2Hn3mV	3.50		-8.08	-4.59	19.9	3.0m./VERT	24.5	AVG
1583.36	2Hn3mV	4.88		-7.91	-3.03	19.9	3.0m./VERT	22.9	AVG
1608.73	2Hn3mV	4.81		-7.20	-2.39	19.9	3.0m./VERT	22.3	AVG
1178.80	2Hn3mV	6.52		-10.31	-3.79	19.9	3.0m./VERT	23.7	AVG
1164.64	2Hn3mV	6.75		-10.41	-3.66	19.9	3.0m./VERT	23.6	AVG
1221.18	2Hn3mV	7.39		-9.36	-1.97	19.9	3.0m./VERT	21.9	AVG
1276.13	2Hn3mV	6.98		-9.22	-2.24	19.9	3.0m./VERT	22.1	AVG

Table 3. GPS Bands 20˚ at 3 Meters Height

Frequency (MHz)	AF Table	Test Data (dBuV)	Additional Factor	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
1183.38	2Hn3mV	5.74		-10.31	-4.57	19.9	3.0m./VERT	24.5	AVG
1165.14	2Hn3mV	4.81		-10.41	-5.61	19.9	3.0m./VERT	25.5	AVG
1221.19	2Hn3mV	5.52		-9.36	-3.84	19.9	3.0m./VERT	23.7	AVG
1233.16	2Hn3mV	4.29		-9.30	-5.01	19.9	3.0m./VERT	24.9	AVG
1600.06	2Hn3mV	20.69		-7.24	13.45	19.9	3.0m./VERT	6.5	AVG
1566.65	2Hn3mV	3.30		-8.08	-4.78	19.9	3.0m./VERT	24.7	AVG
1576.60	2Hn3mV	3.39		-8.08	-4.69	19.9	3.0m./VERT	24.6	AVG
1608.98	2Hn3mV	7.85		-7.20	0.65	19.9	3.0m./VERT	19.2	AVG
1596.10	2Hn3mH	11.07		-7.94	3.13	19.9	3.0m./HORZ	16.8	AVG
1566.63	2Hn3mH	9.27		-8.10	1.16	19.9	3.0m./HORZ	18.7	AVG
1576.58	2Hn3mH	10.04		-8.10	1.94	19.9	3.0m./HORZ	18.0	AVG
1600.05	2Hn3mH	22.97		-7.26	15.71	19.9	3.0m./HORZ	4.2	AVG
1219.29	2Hn3mH	8.20		-9.37	-1.18	19.9	3.0m./HORZ	21.1	AVG
1178.63	2Hn3mH	10.17		-10.14	0.03	19.9	3.0m./HORZ	19.9	AVG
1191.93	2Hn3mH	9.97		-10.07	-0.10	19.9	3.0m./HORZ	20.0	AVG
1230.69	2Hn3mH	7.75		-9.31	-1.56	19.9	3.0m./HORZ	21.5	AVG

The EUT meets the requirements of CFR 15.509 (e) at all of the testing heights. At 1 meter height the worst case margin is 1.2 dB, at 2 meters height the worst case margin is 5.7 dB, and at 3 meters height the worst case margin is 4.2 dB. This is evidence to suggest that as the EUT's height increases from the ground, the radiated emissions are not affected, and the worst case configuration was with the EUT at a test height of 1 meter.

Duty Cycle

The duty cycle was measured with the EUT operating in normal operation mode with its maximum duty cycle. A screen shot of the data and duty cycle calculation are presented below.

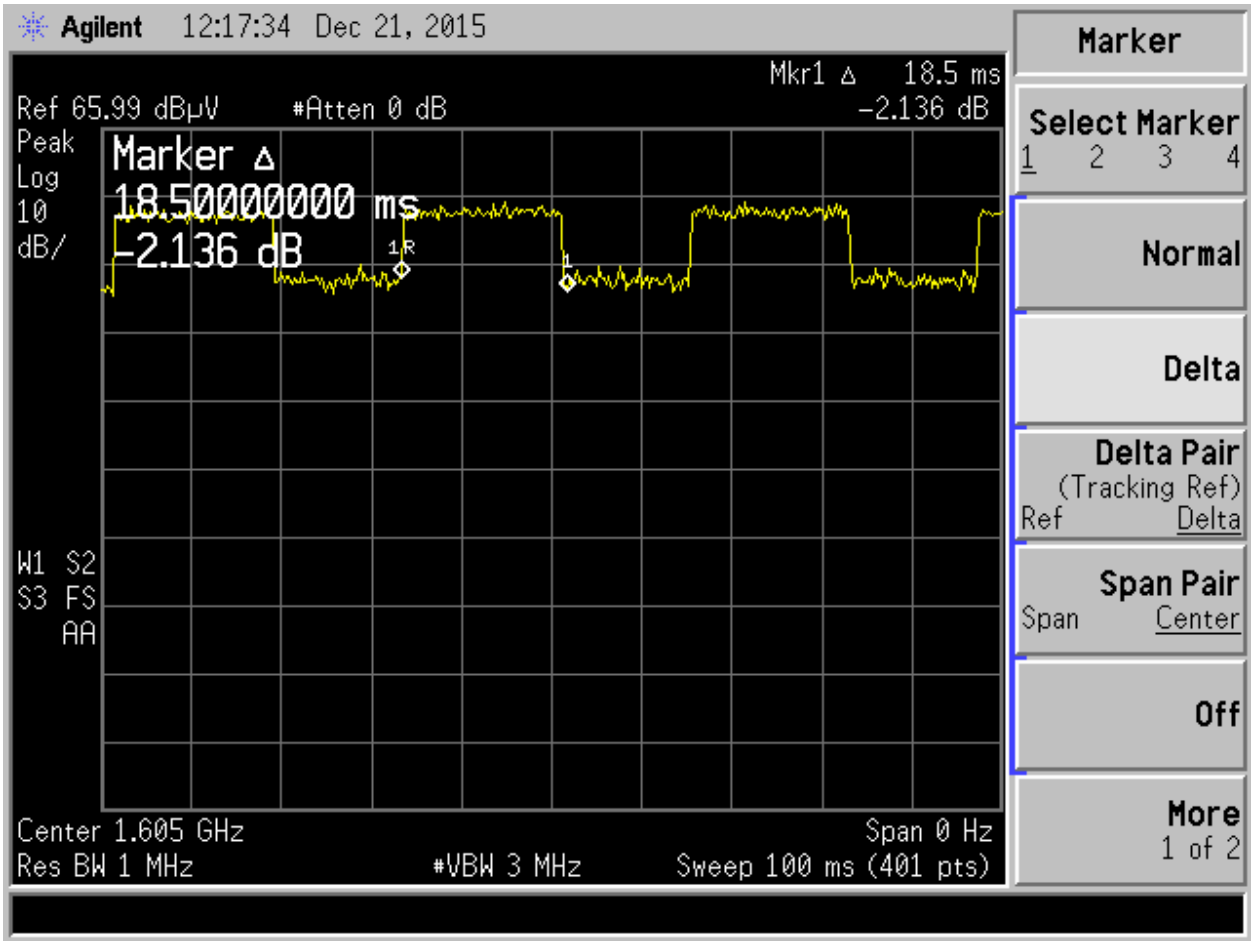

Figure 1. TX On

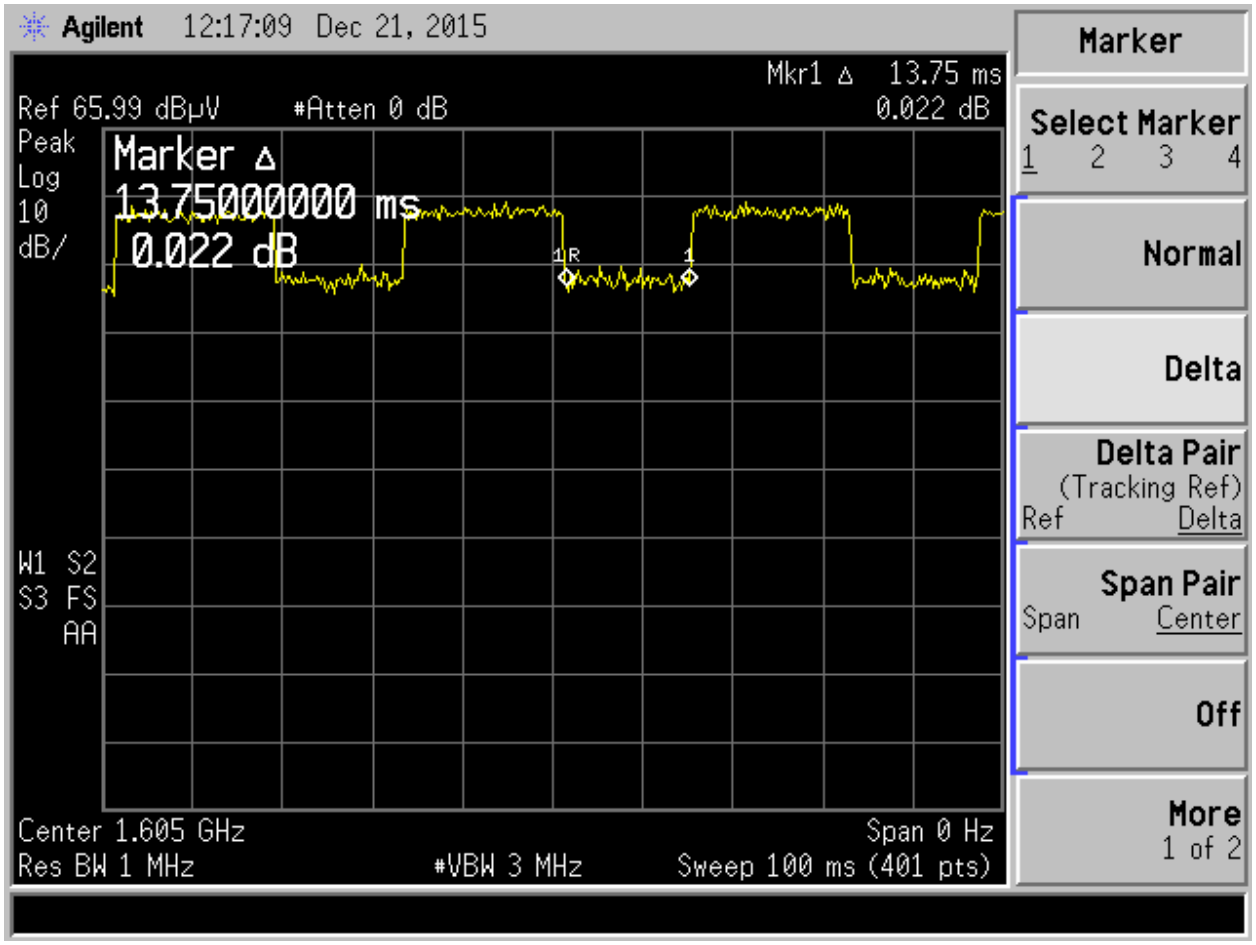

Figure 2. TX Off

Pulse Train = TX On (from Figure 1) + TX Off (from Figure 2)
= 18.5 ms +13.75 ms
= 32.25 ms

Duty Cycle = TX On (from Figure 1) / Pulse Train (from Calculation above)
=18.5 ms / 32.25 ms
= 0.57 = 57 %

Duty Cycle Correction factor = 20* LOG (Duty Cycle)
= 20*LOG(0.57)
= -4.83 dB

Peak and Average Maximum EIRP Emissions Data

The maximum radiated emission, f_m, was found at an EUT height of 1 meter, incline of 20˚, with the RBW and VBW both set to 3 MHz. The data is presented below. The limits displayed in the table below are from CFR 15.509 (f) and 15.521 (g).

Table 4. f_m Field Strength 1 Meter Height

Frequency (MHz)	AF Table	Test Data (dBuV)	Additional Factor	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2203.40	2Hn3mH	61.56		-5.27	56.29	70.8	3.0m./HORZ	14.5	**PK**
1890.60	2Hn3mH	62.34		-6.81	55.53	70.8	3.0m./HORZ	15.3	**PK**
1519.90	2Hn3mH	63.14		-8.88	54.26	70.8	3.0m./HORZ	16.5	**PK**
3049.10	2Hn3mV	55.12		-1.18	53.94	70.8	3.0m./VERT	16.9	**PK**
2203.40	2Hn3mV	53.77		-5.29	48.48	70.8	3.0m./VERT	22.3	**PK**
2574.10	2Hn3mV	53.91		-2.67	51.24	70.8	3.0m./VERT	19.6	**PK**

The emission, f_m, was recorded at 2203.4 MHz and was measured to have a field strength of 56.29 dBµV at 3 meters. The calculations below are to determine the peak and average EIRP of the EUT when measured with a RBW of 1 MHz..

Peak f_m Field Strength at 3 meters (RBW 3 MHz) = 56.29 dBµV/m

Peak f_m Field Strength at 3 meters (RBW 1 MHz) = 56.29 dBµV/m – 20LOG(3/1) dB
= 56.29 dBµV/m – 9.5 dB
= 46.79 dBµV/m

Peak f_m EIRP (RBW 1 MHz) = 46.79 dBµV/m – 95.2 m^2/µV
= **-48.41 dBm EIRP**

Average f_m EIRP (RBW 1 MHz) = -48.41 dBm + Duty Cycle dB
= -48.41 dBm – 4.83 dB
= **-53.24 dBm EIRP**

Test Equipment Used

Below is a list of the test equipment used to collect the test data.

Table 5. Test Equipment

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	1/28/2015
HORN ANTENNA	SAS-571	A.H. Systems	605	8/25/2015 2 yr.
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/1/2015

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

Test Photographs

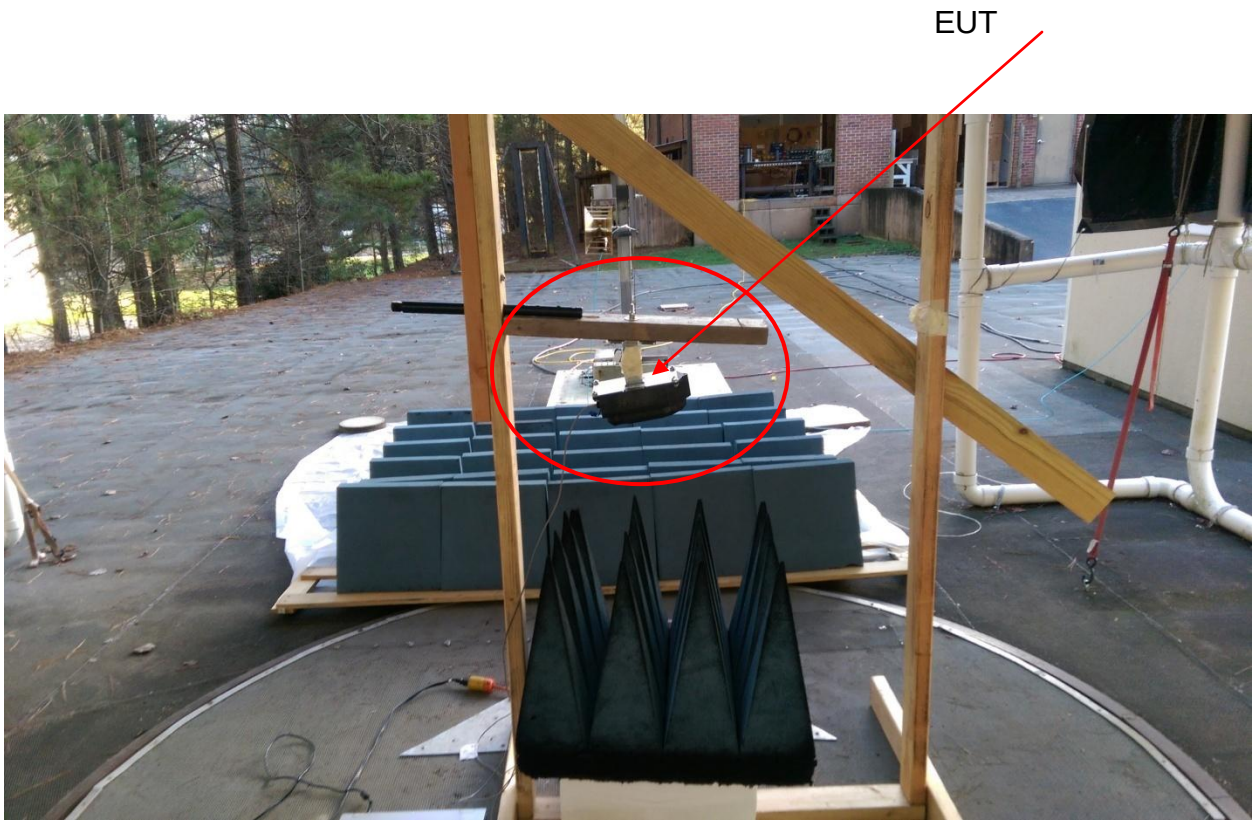

Figure 3. Radiated Emissions Test Configuration at 1 Meter Height

Figure 4. Radiated Emissions Test Configuration at 3 Meter Height

Conclusion

Based on the data presented above, it is our opinion that the EUT meets the requirements of CFR 15.509 (e) at all of the testing heights, with 1 meter being the worst case configuration. We also believe that the EUT meets the requirements of CFR 15.509 (f).

Based on the above calculations, the peak and average EIRP, with a 1 MHz RBW, are 8.41 dBm and -53.29, respectively.